Idaho State Department of Agriculture Nursery, Landscape and Floral Research Interim Progress Report

Grant # NAC/ISDA 2010-8

1. **Title of Project:** Mutation Breeding of Penstemon for Use In The Green Industry

2. **Name of researchers:** Brad Geary (principle), Mikel Stevens, and Rhyan Dockter

3. **University or research facility:** Brigham Young University

4. **Date of Report:** January 5, 2011

5. **Time period covered by the report:** January 2010 – January 2011

6. **Funding agency and amount of grant:** Idaho State Department of Agriculture Nursery, Landscape and Floral Research Grant. $7,800.00

Project summary:
Over the past year, we have made good progress toward our technical goals of producing ornamental improvements of Penstemon. In addition to producing a large number of plants in varying stages of development, we have a good representation of sets of test plants utilizing varying concentrations of both EMS (ethyl methanesulfonate [which produces gene mutations]) and Treflan (producing changes in total number of chromosomes) and have selected several species for each. These plants are being grown either in our greenhouse or in a field in Spanish Fork, UT to meet their need for vernalization. Our current collections of both EMS and Treflan treated plants are summarized in the tables below.

EMS Trials:
Of the EMS treated Penstemon located at Spanish Fork, UT, 100 plants were bagged to promote self-fertilization. Seed were collected from bagged plants and cleaned during the summer and fall 2010. This produced approximately 1600 M_1 (first generation seed after mutation event) seed from 84 bags (some of the plants/bags did not contain seed). The generation "M_0" is the generation (the plant) that mutation treatment was applied. The seed yield of the M_0 self-pollinated (bagged) plants was approximately 19.1 seeds per bag. M_0 plants allowed to naturally cross pollinate yielded approximately 1200 seeds per bag. Since the mutations caused by EMS are usually recessive, we will expect a higher percentage of expressed mutations in the selfed M_1 progeny over those seed which were naturally allowed to cross-pollinate. In many of the selfed M_1 seed, we can expect as high as ¼ of the seed (according to Mendellian inheritance) to express a mutated trait. At this time only 50 seeds of selfed M_1 0.5% EMS treated *Penstemon strictus* have been planted. Of the 50 seed, approximately 11 germinated. Of the 11 germinated 10 did not survive a week past germination, suggesting an expected weakness in these mutants. Currently there is only 1 surviving M_1 *P. strictus* which is not mature enough to observe its horticultural characteristics. Efforts to germinate the selfed M_1 Penstemon seed will continue over the next few months. Furthermore, we will plant open pollinated M_1 seed and work on those using a different breeding management strategy in an effort to maximize our potential to identify

horticulturally friendly characteristics. Using this breeding strategy of natural "open pollination" will not allow multiple recessive mutations to express in one in the first generation. Many of these mutations are deleterious and with an abundance of negative mutation comes high mortality which we are observing. By allowing out-crossing the number of mutations are diluted in the hope of an improved search for horticulturally adventitious mutation event such as dwarfism, reduced seed dormancy and second year flowering, flower and foliage variegation, improved flower size, unique flower colors, male sterility and other valuable characteristics. Although this breeding system is of greater efficiency in searching through a high number of mutation events with reduced plant mortality the caveat of this approach is that it greatly increases the time to identify valuable characteristics. The reason for this is that it takes multiple generations and many more plants to allow a given characteristic to express.

Treflan Trials:
Since our last report we have treated many more Penstemon with the chromosome doubling agent, "Treflan." These plants are currently being grown in our greenhouse. We have had good success in treating *P. strictus*, *P. smallii* and *P. palmeri*. We have nearly completed three replications where we are comparing Treflan treatments ranging from 0.05 - 2.5% of active ingredient. We would like to do two additional repetitions and possibly include two more species (*P. rostriflorus* and *P. sepalulus*). Early germination tests are currently being done on those species. At present, only a few flow cytometry tests have been performed to determine polyploidization for plants germinated. We expect that our results this year will be similar to last year (30-40% success in polyploidization). Those tests will be done within the next couple months (January – April, 2011).

Currently we have nine confirmed and three unconfirmed polyploids/polyploid chimeras and several hundred untested Treflan treated plants in our greenhouse. As of yet we have not had much success in inter- or intra-specific crosses using our polyploid Penstemon. Mutations caused by the Treflan as well as odd ploidy count in most cases can damage the viability of the progeny thus making the crosses difficult. Although viable offspring are rare, increasing the number of polyploid plants for potential crosses will increase our chances for success. For this reason we have been putting much of our efforts this year into creating more polyploids. We expect that our new set of Treflan treated plants will yield new polyploids and more opportunities to create viable wide crosses which will expand our ability to tap into horticulturally useful characteristics presently "locked" in species less well adapted to urban landscapes.

Anticipated outcomes: This next year (2011) our newly grown Treflan treated Penstemon will be tested for polyploidization, and new crosses will be attempted among polyploids in an attempt to create inter-specific hybrids. Additional polyploids will be produced by treating more Penstemon seedlings with Treflan, and within the next few weeks, more M_1 EMS treated Penstemon will be germinated. We anticipate that among these plants, interesting phenotypes will be observed within a few months of germination. It is anticipated that both EMS and Treflan seedlings will be planted into field plots in Provo, UT this coming spring/summer 2011. The seedlings will then be allowed to vernalize over winter 2011/12 and we will then be able to perform crosses spring 2012 and observe the horticultural characteristics on a much larger mutant population. Similar tests will continue to be conducted with our older trials that are currently in Spanish Fork, UT.

Our Current Collection of EMS Plants

In Field (1.5-2.5 years old)

Species	Treatment	% treatment	# Plants
P. strictus	EMS	0.025	44
P. strictus	EMS	0.075	23
P. strictus	EMS	0.225	6
P. strictus	EMS	0.500	48
P. strictus	EMS	0.675	54
P. strictus	EMS	0.850	8
P. strictus	EMS	0.900	9
P. strictus	EMS	1.000	1
P. griffinii	EMS	0.500	5
P. cobaea	EMS	0.900	24
P. cobaea	EMS	1.000	10
P. tubaeflorus	EMS	0.500	18
P. tubaeflorus	EMS	0.850	16
P. tubaeflorus	EMS	1.000	31
P. venustus	EMS	0.675	1
P. psuedospectabilis	EMS	0.850	1

In Greenhouse (0-1.5 year old)

Species	Treatment	% treatment	# Plants
P. strictus	EMS	1.000	24
P. rostriflorus	EMS	1.000	44
P. eatonii	EMS	1.000	150
P. eatonii	EMS	1.500	4
P. eatonii	EMS	2.000	2
P. smallii	EMS	1.000	205
P. sepalulus	EMS	1.000	68
P. barbatus	EMS	1.000	46
P. palmeri	EMS	1.000	220

Our Current Collection of Treflan Plants

In Field (1.5-2.5 years old)

Species	Treatment	% treatment	# Plants
P. strictus	Treflan	0.325	1
P. whippleanus	Treflan	0.025	2
P. whippleanus	Treflan	0.086	6

P. pachyphyllus	Treflan	0.050	1
P. secundiflorus	Treflan	0.150	19
P. palmeri	Treflan	0.086	4
P. palmeri	Treflan	0.150	6
P. palmeri	Treflan	0.325	2
P. tubaeflorus	Treflan	0.086	1
P. tubaeflorus	Treflan	0.150	1

In Greenhouse (0-1.5 year old)

Species	Treatment	% treatment	# Plants
P. strictus	Treflan	0.050	63
P. strictus	Treflan	0.075	60
P. strictus	Treflan	0.100	113
P. strictus	Treflan	0.500	65
P. strictus	Treflan	1.000	22
P. strictus	Treflan	1.500	24
P. strictus	Treflan	2.000	17
P. strictus	Treflan	2.500	23
P. smallii	Treflan	0.050	112
P. smallii	Treflan	0.075	115
P. smallii	Treflan	0.100	96
P. smallii	Treflan	0.500	71
P. smallii	Treflan	1.000	42
P. smallii	Treflan	1.500	55
P. smallii	Treflan	2.000	27
P. smallii	Treflan	2.500	57
P. palmeri	Treflan	0.050	32
P. palmeri	Treflan	0.075	53
P. palmeri	Treflan	0.100	48
P. palmeri	Treflan	0.500	41
P. palmeri	Treflan	1.000	8
P. palmeri	Treflan	1.500	9
P. palmeri	Treflan	2.000	36
P. palmeri	Treflan	2.500	17